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ABSTRACT

The availability and application of particular memory strategies by deaf children and adults was examined. In the first study, 20 younger (mean age, 6 years, 3 months) and 20 older (8 years, 8 months) children's use of rehearsal strategies was examined with a serial probe task. All four types of stimuli (animals, nonsense shapes, hands, print) elicited strong primacy effects in the serial learning curve, and overt labeling and gesturing during stimulus presentation. Findings suggest that the children tested were using appropriate rehearsal strategies. A subsequent free recall study with 60 third-, fifth-, and seventh-grade deaf children was designed to determine if children would spontaneously group items by semantic category during study and/or recall phases of the task. Results showed that deaf children used semantic clustering and were able to enhance recall from instruction in categorization. A third study concerned deaf adults' use of categorization. Two bases for categorization were available: categories based on semantic meaning (e.g., foods, occupations) and categories based on formational similarity of signs (e.g., with signs for "Train," "Egg," "Chair," "Name," forming one group). While Ss were able to group items according to formational similarity when asked to do so, their spontaneous preference was to cluster by semantic meaning. This finding is parallel to studies with hearing people who virtually always favor semantic meaning to surface item features (e.g., rhyming words) as the basis or organization. Findings suggest that, while it may not be neccessary to provide instruction in memory strategies per se, it may be useful to provide instruction that increases the extent to which deaf individuals (1) have conscious knowledge of the availability of strategies, (2) recognize under what circumstances the available strategies may be applied, and (3) organize material to allow the optimal application of these strategies. (Author/CL)

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THE DEVELOPMENT AND USE OF MEMORY STRATEGIES BY DEAF CHILDREN AND ADULTS

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Abstrac

The cognitive and occupational achievements of deaf individuals often compare unfavorably when related to the accomplishments of their hearing peers (Liben, 1978). An important goal of research is to understand why these deficits arise, and how they may be prevented or remediated. While this goal is intractable when stated in global form, it can be achieved by studying a series of particular cognitive skills. One important skill is the ability to memorize. Memory is of importance for learning material in school and for succeeding in everyday living and occupational tasks. Furthermore, memory skills may be especially important for deaf people, since information acquired incidentally by hearing people (e.g., linguistic information) must be memorized intentionally by deaf people.

The availability and application of particular memory strategies by deaf children and adults was examined. In the first study, 20 younger (mean age, 6 years, 3 months) and 20 older (8 years, 8 months) children's use of rehearsal strategies was examined with a serial probe task. All four types of stimuli (animals, nonsense shapes, hands, print) elicited strong primacy effects in the serial learning curve, and overt labeling and gesturing during stimulus presentation. These findings suggest that the children tested were using appropriate rehearsal strategies.

A subsequent free recall study with 60 third-, fifth-, and seventh-grade deaf children was designed to determine if children would spontaneously group items by semantic category during study and/or recall phases of the task. Results showed that deaf children used semantic clustering and were able to enhance recall from instruction in categorization.

A third study concerned deaf adults' use of categorization. In these studies, two bases for categorization were available, specifically, categories based on semantic meaning (e.g., foods, occupations) and categories based on formational similarity of signs (e.g., with signs for TRAIN, EGG, CHAIR, NAME, forming one group). While subjects were able to group items according to formational similarity when asked to do so, their spontaneous preference was to cluster by semantic meaning. This finding is parallel to studies with hearing people who virtually always favor semantic meaning to surface item features (e.g., rhyming words) as the basis of organization.

While it may not be necessary to provide instruction in memory strategies per se, it may be useful to provide instruction that increases the extent to which deaf individuals (a) have conscious knowledge of the availability of strategies, (b) recognize under what circumstances the available strategies may be applied, and (c) organize material to allow the optimal application of these strategies.

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Introduction

The cognitive and occupational achievements of deaf individuals often compare unfavorably when contrasted with the accomplishments of their hearing peers (e.g., Liben, 1978a). An important goal of research is to understand why these deficits arise, and how they may be prevented or remediated. While this goal is intractable when stated in global form, it can be achieved by studying a series of particular cognitive skills. One important skill, focused on here, is the ability to memorize. Memory is of importance for learning material in school and for succeeding in everyday living and occupational tasks. Furthermore, memory skills may be especially important for deaf people, since information acquired incidentally by hearing people (e.g., linguistic information) must be memorized intentionally by deaf people. The purpose of the present paper is to describe a series of studies on the use of memory strategies by deaf children and adults, and to suggest some avenues for further research and educational applications.

A developmental approach. The overriding question from the perspective of basic research as well as from the perspective of educational intervention is whether deaf people have the same memory processes available to them as hearing people, and if so, whether they are able to implement these strategies as efficiently and appropriately. It is not sufficient, however, simply to compare absolute levels of memory performance by deaf and hearing individuals. Too many factors vary simultaneously between the two groups to make such comparisons useful (e.g., different experiences, reading levels, knowledge of stimulus materials). For much the same reason, developmental psychology has also been characterized by disenchantment with simple comparisons of absolute levels of performance between younger and older children. There are now few attempts to document older children's superior performance on memory tasks. Rather, current interest is in discovering what process differences may lead to different levels of performance

(Liben, 1982). As a result, the literature on memory development in hearing children provides valuable models for the study of memory processes in deaf individuals.

Much of the process-oriented developmental memory research has taken place within the organizing framework of a model of memory originally proposed by Atkinson and Shiffrin (1968) in which "structural" components of memory were distinguished from "control processes." The structural component of memory refers to the permanent features of memory, composed of the sensory register, the short-term store, and the long-term store. These structural components may be likened to the hardware of a computer since they cannot be altered for particular memory problems. In contrast, the control processes of memory are the variable mechanisms that may be selected by the individual for a particular memory task. The control processes are thus analogous to computer software insofar as they may be changed--like a computer program--depending upon the particular memory problem at hand.

There is general (although not universal) consensus that developmental changes in the structural components of memory have, at most, only a small impact on the observed age-linked increments in memory performance (Belmont & Butterfield, 1969; Chi, 1976; Huttenlocher & Burke, 1976), while changes in control processes have a dramatic effect (see review by Liben, 1982). Older children are far more likely than younger children to use appropriate memory strategies in a wide variety of tasks (Kail & Hagen, 1977; Ornstein, 1978).

In interpreting this age-linked difference in the use of memory strategies, the competence/performance issue has been central (Overton & Newman, 1982). Specifically, a central question has been whether young children's failure to use appropriate strategies reflects an inability to use strategies (that is, a "mediation deficiency," see Flavell, 1970), or instead, reflects a failure to

produce these strategies spontaneously (i.e., a "production deficiency"). An extensive program of research by Flavell and his colleagues (e.g., Keeney, Cannizzo, & Flavell, 1967; Flavell, 1970; Flavell, Beach, & Chinsky, 1966; Moely, Olson, Halwes, & Flavell, 1969) has provided considerable evidence in favor of the production-deficiency explanation. Young children appear to be capable of successfully using various strategies long before they invoke these strategies spontaneously.

The distinction between the capacity for, versus utilization of, memory competencies is also useful in approaching the comparison of deaf and hearing people's memory skills. To examine the competence/performance issue, one useful strategy is to use tasks and measures that externalize the competencies of interest. With this approach, it is possible to determine whether a deaf subject's poorer performance is a function of not having a particular strategy altogether, or if instead, it is a function of a reduced ability in implementing that strategy. A second useful research strategy is to manipulate various features of the task to determine if these variations affect the expression of cognitive competencies. If these competencies are evident with some, but not other tasks, the importance of performance variables (or activation/utilization, see Overton & Newman, 1982) is demonstrated.

These considerations were central to the design of the studies described in this paper. That is, rather than designing studies to catalogue deaf and hearing subjects' absolute levels of performance on particular memory tasks, these studies were designed to provide data on the processes used by subjects in approaching these tasks. Furthermore, as a mechanism for exploring the competence/performance issue, each study contained a stimulus or instructional manipulation designed to determine whether some situations would be differentially conducive to the application of potentially available strategies.

Rehearsal. Perhaps the most frequently studied control process in the literature on the development of memory is rehearsal. Rehearsal is the process by which the items to be remembered are repeated by the individual to prevent their loss from working memory, and to permit the transfer of items into long-term memory. There has been evidence from research on hearing children that older children are more likely to use rehearsal strategies and to use more elaborated forms of rehearsal than are younger children. For example, Flavell, Beach, and Chinsky (1966) asked kindergarten, second-, and fifth-grade children to remember a series of items after a delay. Flavell, et al. (1966) found that older children were more likely than younger children to show overt signs of rehearsal (such as lip movements). Furthermore, of those children not giving overt signs of rehearsal, older children were more likely to report having used covert rehearsal. It is important to note that the use of rehearsal has been linked to recall performance. Keeney, Cannizzo, and Flavell (1967) found that first-grade children who spontaneously rehearsed remembered more items than first-grade children who had not rehearsed. This difference was then eliminated through subsequent instruction on rehearsal.

In addition to studies that assess the use of rehearsal relatively directly, there have also been studies that have inferred subjects' rehearsal on the basis of serial learning curves. In the serial probe task (Atkinson, Hansen, & Bernbach, 1964; Hagen & Kingsley, 1968; Kingsley & Hagen, 1969), subjects are asked to locate one of a series of recently displayed items. In adults and older children, memory is better for items presented early and late in the list than for items presented in the middle. Items late in the list are thought to be remembered well ("recency effect") because they are still in working memory. Items early in the list are thought to be remembered well ("primacy effect") because there has been more opportunity for rehearsal of these items. Young

children typically show recency, but not primacy effects, suggesting a failure to use rehearsal strategies.

To examine the use of rehearsal strategies in deaf children, we gave serial probe tasks like those just described to 20 younger (mean age, 6 years, 3 months) and 20 older (8 years, 8 months) deaf children (Liben & Drury, 1977). Of interest were both direct and indirect indices of rehearsal. Direct evidence for rehearsal was obtained by observing the children during the testing itself. Indirect evidence was obtained by examining the serial learning curves for primacy effects.

Given our interest in the issue of competence/performance discussed above, we were also interest in exploring whether deaf children's tendency to use rehearsal strategies might vary as a function of the stimulus materials. We hypothesized that in many tasks, deaf children might be less likely than hearing children to use a rehearsal strategy because they might not have readily available labels with which to rehearse the stimulus items. To determine whether the availability of labels does affect deaf children's spontaneous use of a rehearsal strategy, we prepared several sets of stimulus materials. For one stimulus set we selected a number of highly familiar animals for which even the youngest children in the sample had English labels. To provide a strong contrast on the dimension of labelability, an alternative stimulus set contained pictures for which none of the children had prior labels. To be certain that children would not have ready labels for these stimuli, we used line drawings of nonsense forms developed by Glucksberg and Krauss (1967) for use in a communication task. Data from that communication study, as well as from an earlier memory study (Kingsley & Hagen, 1969), provided evidence that while the forms were visually discriminable, they were not readily labelable by young children. With respect to the contrasting stimulus sets of animals versus nonsense forms, we expected to find more evidence for rehearsal with the labelable animals than with the unlabelable nonsense forms.

An additional stimulus comparison was included in this study to address the possibility that kinesthetic (manual) rehearsal might be especially useful, but that young deaf children might not spontaneously recognize its potential applicability. Thus, a second pair of stimuli was used. In one, the potential for manual encoding and rehearsal was present, but not explicit. In the other, the relevance of manual encoding was explicit. Specifically, the former set of stimulus materials consisted of letters written in lower-case print, while the latter set contained the same selection of letters, but presented with pictures of hands shown in the appropriate letters of the alphabet. Our expectation was that because kinesthetic encoding and rehearsal would be explicit in the "hands" but not the "print" stimuli, we would find more evidence of rehearsal with hands than print.

In summary, 40 deaf children were given a series of serial probe tasks. Each child (tested individually) was given either the animal or form stimuli, and either the print or hands stimuli. Evidence from direct observation of children during the presentation of the materials, as well as evidence from the shape of the serial learning curves, suggested that the deaf children tested were surprisingly active memorizers. Specifically, they demonstrated high levels of activity during the task by spontaneously labeling the stimuli, inventing verbal labels for nonsense forms, and even miming the nonsense forms. (One child, for example, rocked back and forth to represent a nonsense form that had a curved base.) Furthermore, the serial learning curves showed strong primacy effects which are traditionally attributed to rehearsal strategies. Strikingly, these primacy effects were evident with both animals and nonsense forms, and with both print and hands. It would appear, then, both from the use of observable strategies, and from the shapes of the serial learning curves, that deaf children spontaneously use appropriate rehearsal strategies, regardless of whether a verbal English label

is or is not readily available (animals versus nonsense forms, respectively) and regardless of whether manual encoding is or is not explicitly given in the stimuli (hands versus print, respectively).

Free recall: Semantic clustering. A second control process that has attracted considerable attention in the literature on memory development is semantic clustering. In the paradigm used to examine this strategy, subjects are given randomly-presented lists of items which they are then asked to recall in any order (a "free recall" task). Of interest is whether subjects organize their recall by grouping or clustering the items they recall into the conceptual categories that have been built into the list. For example, a list of 20 items might contain five items in each of four categories such as vehicles, occupations, sports, and buildings. A subject who makes use of the categorical nature of the list might name all the vehicles recalled first, followed by all occupations recalled, then all sports, then all buildings. In contrast, a subject who fails to use a clustering strategy would recall an item from one category, then another, back to the first category, and so on. As with the use of rehearsal strategies, research on memory development has demonstrated a reliable age-linked change in the tendency to cluster items in free recall tasks. Younger children typically recall items in random order, whereas older children and adults tend to cluster their recall output by semantic category.

The investigation described here was concerned with examining the use of clustering strategies by deaf children (Liben, 1979). The expectation was that, at least at younger ages, deaf children would be less likely than hearing children to categorize their recall by semantic category. At the same time, however, the cognitive processes underlying the successful use of semantic categorization were thought to be available, even to the young deaf children. To determine whether any apparent failure to use semantic categorization was simply a problem of

activating or utilizing underlying competence, the instructions were manipulated in this study. Some children were given the study and test trials without being explicitly told of the categorical nature of the list. Other children were specifically informed of the categorical structure and told of its potential utility for memory. Thus, the basic hypothesis examined in this study was that deaf children would be less likely to make use of a semantic clustering strategy spontaneously due to a variety of experiential deficiencies (Furth, 1966; Liben, 1978b). Given that the cognitive prerequisites for clustering were expected to be present, however, it was also expected that these children would profit readily from a short instructional manipulation oriented to this strategy.

Specifically, deaf and hearing children in grades three, five, and seven (20 per group, N=120) were given a 16-item free recall task comprised of four foods, four articles of clothing, four pieces of furniture, and four toys. The items were presented in line drawings in a deck of cards so that no two items from the same category followed one another. Subjects were told they were free to use the cards in any way they liked to help them remember the items. All subjects received an initial study-test trial. Between the first and second study-test trials, half the children were told of the categorical nature of the list, asked to sort items into categories, and told of the utility of this structure for remembering. The remaining children were simply given another study-test trial. All children were asked to recall the items a third time by filling out an answer sheet that had been divided into quadrants, each headed by a category label. Although subjects were required to place the items recalled in the appropriate quadrant, they were free to fill in the sheet in any order they chose.

As in the study on rehearsal, both direct and indirect indices of clustering were used. A direct indication of clustering was provided by observing subjects' behavior during the study period. Of interest was whether children would group

the cards into categories during the study period. The indirect measure was obtained during the recall portion of the task. Recall protocols were scored on the extent to which items were recalled in categorical clusters.

As predicted, older children showed more spontaneous clustering than younger children, whether measured by the tendency to sort cards into categories during the study period, or by the tendency to group items from the same category during recall. However, the use of clustering was far from universal even among the oldest children, and thus not surprisingly, the instructional manipulation was found to increase categorical clustering in all grades tested. On the final, cued-recall trial, clustering was equivalent across grades, suggesting that children across a wide age-range cluster their recall equivalently when shown the categorical nature of the list directly. Importantly, however, the predictions with respect to differences between deaf and hearing children were not supported by the data. Deaf and hearing children appeared to use semantic clustering equivalently across the grades tested, and did not benefit differently from the instructional manipulation.

Free Recall: Formational versus semantic clustering. The research just described addressed children's tendencies to make use of semantic or conceptual features of lists to organize study and recall. Lists of items to be memorized may, however, be organized using alternative criteria. One such alternative concerns characteristics of the surface features of the list items themselves. With hearing subjects, for example, free recall has been examined for clustering on the basis of the same initial letters or acoustic similarity such as rhymes (Dolinsky, 1972; Freund & Underwood, 1969; Lauer & Battig, 1972; Shuell, 1969; Wood, 1970, 1972). The general finding from this research with hearing subjects is that subjects prefer to organize on the basis of meaning rather than on the

basis of surface similarities of the items, although the latter can be used under some conditions.

Surface similarities of signs have been shown to be relevant for deaf subjects' performance on short-term memory tasks. Locke and Locke (1971), for example, found that when deaf subjects with relatively poor oral skills were given a short-term memory task with letters, their errors were kinesthetically similar to the original letters (in the manual alphabet). Similarly, Bellugi, Klima, and Siple (1975) have provided evidence that with words or signs as stimuli, deaf subjects' intrusion errors in short-term memory are formationally similar to the original list items. For example, while hearing subjects show acoustic intrusions in memory (such as substituting the word "boat" for the list item "vote"), deaf subjects produce confusions based on formational similarity in Ameslan (such as substituting the formationally similar sign "tea" for the list item "vote").

The data from these studies suggest that deaf people have stored information about the formational similarity of signs, but they do not provide evidence concerning deaf individuals' tendency to use this information to organize long-term memory. The studies described here were designed to examine this issue (Liben, Nowell, & Posnansky, 1978). Deaf adults were given a series of free recall tasks that contained formationally similar items. In the first study, a 16-item list in either written (words on slides) or signed (videotape) modes was presented to 16 students at the National Technical Institute for the Deaf. The items for the list were selected so that they could be organized either by semantic category (foods, countries, animals, occupations) or by formational category (signs with "F," "A," "U," or "Open" handshapes). Subjects were given a series of study-test trials until they reached a criterion of one perfect recall. The data showed that regardless of presentation or response mode (written or signed), subjects showed evidence of clustering by semantic rather than by formational similarity.

Several factors may have been responsible for the absence of clustering based on formational similarity. First, the subjects were not highly selected for low oral skills, and thus may not have relied upon sign language as a primary processing mode. Indeed, Conrad (1970) has shown that individual deaf subjects differ significantly in their optimal processing modes in relation to their own oral-aural skills. Second, the materials themselves may have provided differently strong categories for formational and semantic similarities. That is, the semantic categories could be considered relatively obvious and elementary, whereas the formational similarities might be considered relatively subtle. Formationally similar items were defined only by shared handshape which is just one of several parameters along which signs vary (Bellugi & Klima, 1978; Stokoe, Casterline, & Croneberg, 1965; Friedman, 1977). Thus, a second study was undertaken to determine whether formational similarity would be evident with modifications in both the subject sample and the stimulus materials.

The deaf individuals who participated in the next study were selected to insure that they were people who normally rely upon manual communication. This was accomplished by sampling from among NTID students who were prelingually deaf, who performed at high levels on a test of skill in receiving signs and at low levels on a test of skill in receiving oral communication.

The stimulus materials were modified to enhance formational similarity and to eliminate the experimenter-provided semantic categories. Specifically, the 16-item list was made up of four groups of four signs each that are made at the same location of the body as well as with the same handshape (e.g., signs for "train," "name," "egg," and "chair"). As in the earlier study, both presentation and recall modes were varied between subjects. All subjects were given eight study-test trials, and were asked to return one week later for an additional recall

trial. After the one-week recall, subjects were given an explanation of the categorical nature of the list and then asked for another recall.

The strongest and most important finding of this study was the almost complete absence of spontaneous clustering by formational similarity on the initial eight, or the one-week recall trials. Subjects did, however, show high levels of formationally-based clustering on the final recall trial which followed an explanation of the categorical nature of the list. These results suggest that although subjects can use formational criteria for organization, they do not spontaneously do so for a long-term memory task. The failure to organize in this way is especially compelling in this study because the similarity within formational categories was extremely strong, because no competing semantic organizational structure was available in the list, and because subjects were carefully selected for high manual skills.

These findings thus parallel findings from studies with hearing subjects in which materials may be organized on the basis of surface structure of the materials. Hearing subjects, too, prefer to organize their recall along conceptual similarities rather than along structural similarities. Additional research is needed to determine whether deaf subjects could be induced to utilize formational similarities of sign by manipulating the presentation format (e.g., blocked presentation of formationally similar signs). Such manipulations have been shown to be effective in yielding organization by surface features of English in hearing subjects (e.g., Wood, 1972; Ozier, 1978). Regardless of the outcome of such research, the evidence already available suggests that deaf subjects process Ameslan in memory tasks in much the same way that hearing subjects process English. That is, although they possess knowledge of the surface features of the items used for memory tasks, they demonstrate a strong preference for processing items on the deeper level of meaning when possible.

Summary and conclusions. Several process-oriented investigations of deaf children's and adults' memory strategies have been described. First, results from the study of rehearsal suggest that deaf children were remarkably active in serial probe tasks. Children showed overt signs of labeling and rehearsing, and gave indirect evidence for rehearsal in the strong primacy effects of the serial learning curves. Second, research using free recall tasks showed similar evidence for use of appropriate strategies. With semantically categorizable items, children clustered their recall into conceptual groups. Furthermore, a brief instructional suggestion on the utility of categorical grouping served to increase the use of clustering. Even subjects who had not been instructed to use categories to organize their study and recall were able to make use of the categorical nature of the list in organizing recall in the final cued recall trial. Third, results from the studies with adults provide even firmer evidence for the deaf learner's reliance upon meaning for organizing recall. Deaf adults preferred semantic to formational categories to organize their recall when both were available, and avoided formational similarity to organize their recall even when no other experimenter-provided system was provided. This finding held despite the fact that subjects were capable of organizing the list according to formational similarity once the structure of the list had been made explicit.

The pattern of results across studies in highly consistent in suggesting that deaf children and adults have the same kinds of memory strategies available to them as hearing subjects, and show the same preferences when selecting among them. While the precise realization of a particular strategy may differ between deaf and hearing subjects (e.g., manual rather than oral rehearsal), the underlying mnemonic processes appear to be comparable.

Despite the apparent similarity of processes, however, the success of these processes is often reduced among deaf subjects. For example, in both the free

recall studies with children and adults described earlier in this paper, the absolute levels of recall of items were lower in deaf than hearing subjects. Since these deficits do not appear to be accounted for by different kinds of strategies, it is important to direct future research and educational curricula to understanding and facilitating the application of strategies to learning tasks in an efficient and consistent manner. Thus, while it may not be necessary to provide instruction in memory strategies per se, or in the cognitive underpinnings of such strategies, it may well be useful to provide instruction that increases the extent to which deaf learners have conscious knowledge of strategies already available to them and recognize under what circumstances the available strategies may be applied. In addition, it would be useful to focus curriculum development in ways that will enhance the optimal application of strategies already available to the deaf learner.

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